Chapter 7

Conclusion and Future Aspects

7.1 Overview
This chapter of the thesis incorporates the overall conclusions of the present work. Considerable amount of work has been done on human gait analysis through image processing using different method. The present work has been directed to evolve an efficient scheme for automatic determination of behavioral traits through human-gait recognition by extracting different feature using high-end computing approach. The contributions made in this thesis have been summarized and the future scope of the work has been spelt out.

7.2 Summary and Conclusion
The present work comes under multimodal biometrical study. The work has been carried out by considering two biometrical traits human-gait and human-speech. In the present thesis two different tasks has been carried out. The first task is to determine the behavioral traits through human-gait images and the second task is to determine the prosodic features. Finally the validation of detected behavioral trait has been carried out using the speech features.

The work has been carried out in two different phases: modeling and understanding phase. The modeling phase has been carried out for formation of the knowledge based corpus AHGM and AHSM.

In the modeling phase, for AHGM has been carried out in three stages: enhancement, segmentation, feature selection and extraction. The captured digital image may be embedded with some type of distortion such as optical distortion, lighting distortion, position variation and so on. First the captured human-gait image has been fed as input. Then it has been enhanced to remove the distortion present in the input image. In the present work Gaussian filter has been used to filter the human-gait images. Then the discrete cosine transform (DCT) has been utilized to remove the distortion and compressed with loss-less of information. After enhancement the segmentation stage has been carried out for detection boundaries of the object and the Region of Interest (ROI). After detection of object boundaries and ROI the relevant features have been selected and extracted. In the present work physical characteristics of human-gait of the subject have
been extracted. The physiological characteristics that have been extracted are: foot-angle, step-length, knee-to-ankle (K-A) distance, foot-length, shank-width, gait momentum, gait speed and gait energy. Finally a computer algorithm has been developed for formation of the knowledge-based corpus (AHGM) using the extracted human-gait features.

In the same manner the modeling phase has been carried out for formation of AHSM using the human-speech signal. Modeling of AHSM has been carried out in three stages: enhancement, segmentation, feature selection and extraction. Generally the speech signal embedded with noises or distortions due to some factors such as: background and channel noise, electrical noise, pause between words. To reduce the distortions to an acceptable value speech enhancement has been carried out. For removing such distortions, blind source separation (BSS) method has been used in the present work. To enhance the speech signal further discrete wavelet transform (DWT) and discrete cosine transform (DCT) have been utilized. After removal of distortions, further analysis has been carried out in the segmentation stage. Segmentation has been carried out for detection of voiced and unvoiced speech patterns. In the present work zero crossing measurement (ZCM) and modified adaptive vector quantization (MAVQ) have been utilized for segmentation. In the feature selection and extraction stage the relevant speech features have been extracted. In the present work the relevant speech features are pitch, formants, speech duration, speech rate, speech momentum. Extraction of speech features have been carried out using particle-filtering method, and digital signal processing methods. After the extraction of relevant speech features a noise-free knowledge-based corpus (AHSM) has been formed using the methods of ANN.

In the understanding phase, the AHGM and AHSM have been utilized for the mapping and matching of geometric and prosodic features.

In the understanding phase first a test human-gait image has been studied with proper enhancement, preprocessing, detection of region of interest (ROI) and post-processing. In the enhancement stage removal of noise from the human-gait image has been carried out. Later preprocessing stage has been applied for further compression, dilation, erosion and computation of connected-components. Hence detection of region of interest (ROI) has been done using known algorithms or methods from the literature. Then the relevant gait features have been selected and extracted from the test human-gait images. The extracted relevant human-gait features have been stored as a template, say HGTEMPLATE. The feature vectors stored in the HGTEMPLATE has been compared with the feature vectors stored in the AHGM corpus for best-fit matching. In the present work forward-backward
dynamic programming (FBDP) and the genetic algorithm (GA) has employed for best-fit matching. Based on the results of matching classification has been made using support vector machine (SVM) and Bayesian classification. Then the decision has been made whether the subject is possessing normal behavior or abnormal behavior. When the matching of feature vector results to 50-50 percent chance, uncertain behaviour is resulted. Such situations have been handled using SVM and fuzzy rules, in the present work for determination of proper behavioral trait.

Finally the validation of the detected behavioral trait has been carried out using the speech patterns. For validation the video stream of the same test subject that is when the subject is talking while walking has been considered. First the input video data has been separated into 1D data (human-speech) and 2D data (human-gait). The 1D and 2D data have been processed further for extraction of relevant features as discussed in the modeling phase. From human-speech data extraction of four relevant features: pitch, speech duration, speaking rate and speech momentum have been carried out. Similarly from the human-gait data four relevant geometrical features: step length, gait energy, gait momentum and walking speed have been extracted. A computer algorithm has been developed for the validation of the behavioral trait detected in the understanding phase. One-to-one mapping of the speech features and the gait features has been carried out. For this UTAM has been employed as a mapping function. Depending upon the results of mapping classification has been made as “Behavioral trait validated” or “Behavioral trait not validated”. For classification Baye’s classification has been employed.

The present work has been carried out for determination of behavioral traits and prosodic features. Here a new approach of biometrical study has been presented which combines two biometrical traits that is human-gait and human-speech. Determination of behavioral traits has been carried out using the human-gait image frames and the prosodic feature determination has been carried out using the human-speech signal. In the present work human-gait images of 100 subjects walking on normal surface without any footwear and without carrying any weight has been utilized for formation of knowledge based corpus (AHGM). Similarly the human-speech signal of the same 100 subjects have been considered for formation of AHSM. In the present work finally the detected behavioral traits has been validated through speech patterns. The experimental results in the present work have been found to be very satisfactory. The further scope of the present work has been spelt out in the next subsequent section of this chapter.
7.3 Future Aspects

The present work opens new paths and can be further utilized to solve the problems in multimodal biometrics. The present work may be further applied for an application of human gait recognition from temporal View. This work can also be applied in the detection of human in the crowd for the tracking of a wanted person or criminal and detection of gait pattern in video images. For further study, the developed algorithm has to be modified for the detection of gait with an image of the subject with different getups. The present work can be further extended for detection of foot abnormalities, determination of obesity through human-gait images. Also it can also be further extended for determination of asthmatic problems using human gait and human speech.